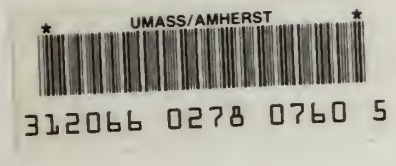

Warehouse Club Trip Generation Study

Produced by the Central Transportation Planning Staff
for the Executive Office of Transportation and Construction,
Commonwealth of Massachusetts

WAREHOUSE CLUB TRIP GENERATION STUDY

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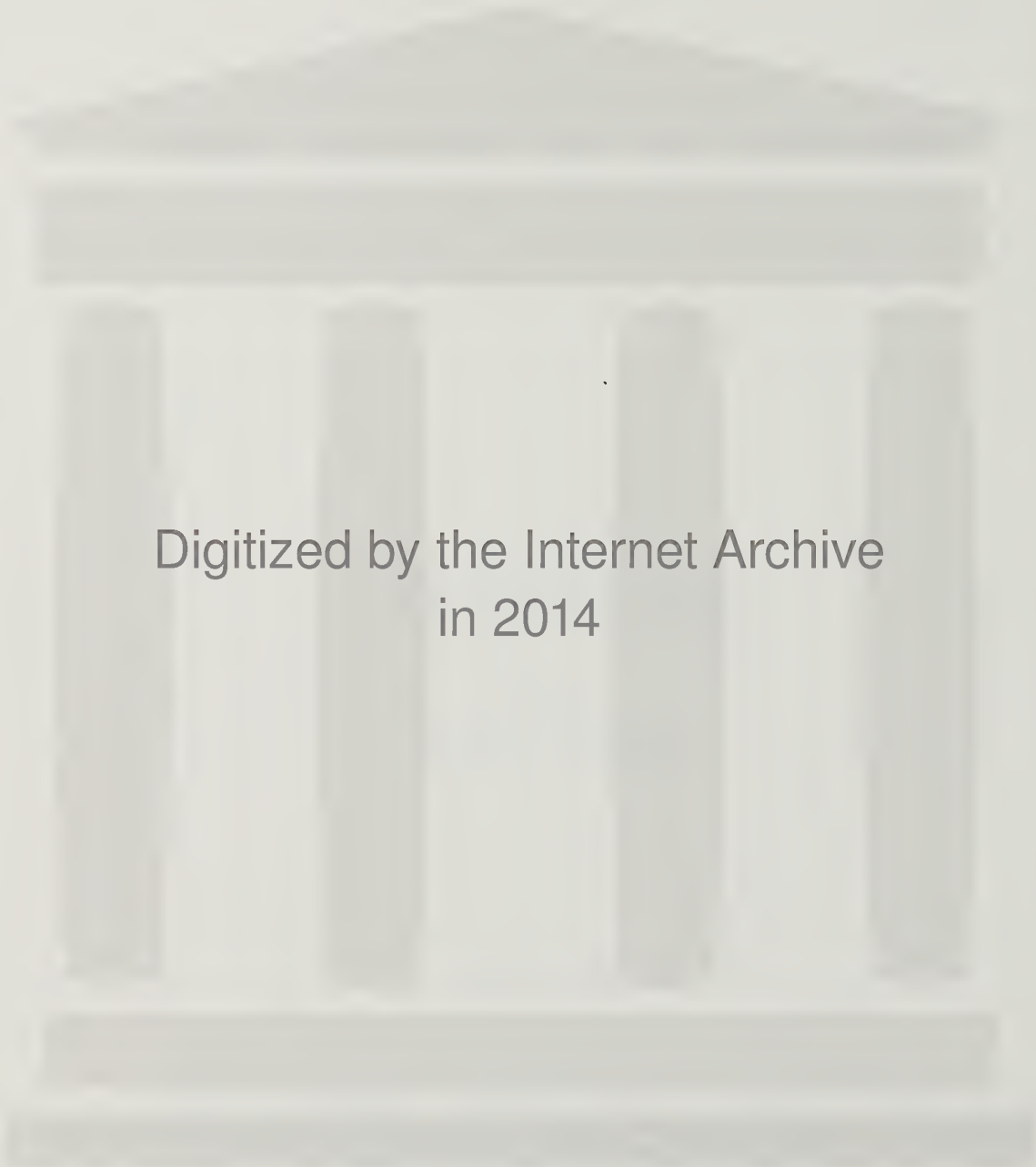

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Introduction

Background

The Central Transportation Planning Staff, technical transportation planning staff to the Boston Metropolitan Planning Organization, has conducted a study of the trip generation characteristics of membership warehouse clubs in Massachusetts. The work was performed under MHD/FHWA contract 93218 for the Executive Office of Transportation and Construction of the Commonwealth of Massachusetts (EOTC). An internal review of the study was conducted by technical staff of EOTC, who concluded that the study was conducted in conformance with recommended ITE guidelines and the data collected appears acceptable for use in predicting vehicle trips for this land use category. The internal review also resulted in several comments, which were responded to and incorporated into the final version of this report.

Trip generation studies seek to establish average trip rates and trip rate equations to be used to predict the likely vehicle trip making characteristics of new or changing land use development, based on known characteristics of that land use, such as building square footage, employment, lot size, etc. This information is vital to a variety of planning and permitting concerns, as well as to those directly involved in land development. Knowledge of anticipated trip generation characteristics is needed to ensure that the necessary infrastructure and traffic control technologies are present to safely facilitate development-related traffic.

The primary source used by most professionals for trip generation rates and equations is the ITE Trip Generation Manual, 5th Edition, published in 1991. ITE maintains a national database of trip generation data and compiles average trip rates and trip generation equations based on this data for an extensive range of land use categories. Many involved with the process of land development, permitting and transportation planning and engineering in Massachusetts believe that national average trip generation statistics do not accurately depict trip making characteristics in Massachusetts. The local ITE chapter, as well as the Massachusetts Environmental Policy Act office, has expressed support for and interest in the effort of developing Massachusetts-specific trip generation studies. The desire for this additional data was the initial impetus for undertaking a Massachusetts-specific trip generation study. The present study of membership warehouse clubs is a first step in this effort.

Selection of Membership Warehouse Clubs for Study

In recent years, there has been a surge in the development of membership warehouse clubs in Massachusetts. This type of merchandise retailing seems particularly well suited to current economic conditions. In addition, the consumer market for this type of retailing has, until recently, remained relatively untapped. Very little data exists on the trip making characteristics of this land use due to its relatively new arrival on the national as well as local retail market. Therefore, because of the current need for data on this land use type, it was felt that this would be the most worthwhile land use category to study. In addition, this is a completely unique form of retailing, making existing trip generation studies of more traditional types of retailing inapplicable.

Objectives of the Study

The objectives of this study were to sample an adequate number of membership warehouse club sites in Massachusetts to determine average trip making characteristics based on several variables. Sites were deemed appropriate for inclusion in the study if they fit the definition of a membership warehouse club in terms of membership policies, sales practices, and similar ranges of goods sold. Only stores which were "stand alone" were surveyed (i.e., they are not part of a shopping plaza or complex). This criterion was necessary to be able to isolate and count those trips going to and from the warehouse club only. An additional objective of this study was to gather data for a full range of appropriate time periods. The few national studies of warehouse club trip generation done nationally sampled a limited range of time periods.

It was intended that the data from the study be used to develop average trip rates and trip generation equations for each independent variable and time period, which could then be applied to proposed development scenarios for new warehouse clubs in Massachusetts as predictors of traffic impacts from the development.

Description of Study

The goal of the study was to identify and survey at least 10 representative sites. Initial identification of potential sites was completed through phone surveys of known warehouse clubs. CTPS staff conducted field surveys of each site to determine whether or not an adequate "cordon" could be established around each building, to allow for a complete and accurate count of each vehicle trip made to and from each site. Only those sites which could be counted in this way were included in the study. This selection process resulted in eight remaining sites which fit the necessary criteria.

Site Attribute Data

For each of the eight sites the following attribute data were obtained: 1) square footage of the building, 2) number of employees (both full and part time, where available), 3) hours of operation, 4) products sold, 5) services available, 6) date the site was first open for business, and 7) membership criteria.

For purposes of this study, square footage of the building refers to the overall size of the building footprint. Because of the nature of the retailing, there is no additional "storage" or warehousing space required, therefore the building footprint size is roughly equivalent to the retail floor space available. For use in the development of the average rates and equations, the total number of employees for each site was utilized. The ratio of full to part time employees did not vary significantly between the sites, with the split being about 50/50. Hours of operation were comparable between sites, therefore resulting in a fairly uniform number of worker-hours at each of the sites. It was therefore not necessary to calculate worker-hours per site as an independent variable.

Traffic Count Data

The following traffic counts were obtained for each site:

1) Seven day continuous ATR 24 hour counts, summarized at 15 minute intervals. Each access drive to the site was counted.

2) Manual counts of entering and exiting vehicles at the same site driveways during the PM peak period (3:00 - 6:00 pm) during a midweek day. These counts were taken simultaneously with the ATR counts and were utilized to verify the accuracy of the ATR counts. These counts were also utilized to determine the PM peak hour of the adjacent street and relevant adjacent street volume for calculation of this rate.

3) Vehicle classification counts were taken during the PM peak period as well.

From the above outlined traffic data, it was possible to determine both 24 hour and peak hour volumes for weekdays (both AM and PM peaks were determined for weekdays), Saturdays, Sundays, and the PM peak of the adjacent street. A consultant was selected through a bid process to collect the count data.

Definition of Land Use Type

For purposes of this study, membership warehouse clubs are described as follows. The clubs require yearly membership, in return for which the member is offered high-quality goods at "warehouse" prices (achieved through bulk buying). The

profitability of the clubs is derived primarily through high sales volumes, with very slim mark up margins and through membership dues. The physical structures are often described as "hangar-like" and offer little in the way of consumer "frills", functioning primarily on a self-service basis. Goods are often available in large sizes or quantities only. The clubs strive to offer a wide range of items, from food, household goods, apparel and jewelry to automotive supplies and appliances. However, the selection is substantially more limited than traditional full-line discount retailers.

In terms of location, the clubs often seek that "ideal" site, off an interstate, near a regional mall, on a large regional roadway facility with good visibility and good market demographics. Building sizes are typically between 100,000 and 135,000 square feet, employing on average around 130 people, half of whom are full time.

Traffic Count and Trip Rate Results

Each individual site will be identified only by a site number, in order to protect the confidentiality of those facilities who agreed to be part of this study.

Site Attribute Data and Traffic Volumes

For each of the eight sites the following data are reported in Table 1 below: Gross Building Square Footage, Number of Employees, Average Weekday 24 hour total volume, Saturday 24 hour total volume, Sunday 24 hour total volume, Average Weekday AM peak hour total and directional volume, Average Weekday PM peak hour total and directional volume, Average Weekday PM peak hour of the adjacent street total and directional volume, Saturday peak hour total and directional volume, and Sunday peak hour total and directional volume.

Employees per 1000 Square Feet

It is sometimes necessary to predict an expected level of employment associated with a proposed development when only the square footage of the proposed facility is known. In this case, it is useful to know what the range and average number of employees per 1000 square feet are for a particular land use type. For the warehouse club sites included in this study, the number of employees per 1000 sq.ft. ranged from .55 to 2.57. For the study sites, the average number of employees per 1000 sq.ft. was 1.44.

TABLE 1

INDIVIDUAL SITE TRIPS BY TIME AND DIRECTION

Site #	TOTAL SQ FT	TOTAL # EMPLOY	AVG WKDAY 24 HR VOL	AM PK HR VOL	AM PK HR IN	AM PK HR OUT	PM PK HR VOL	PM PK HR IN	PM PK HR OUT	ADJACENT PM PK HR	ADJACENT IN	ADJACENT OUT	SAT 24 HR VOL	SAT PK HR	SAT PK HR IN	SAT PK HR OUT	SUN 24 HR VOL	SUN PK HR	SUN PK HR IN	SUN PK HR OUT
1	113000	206	7063	481	250	231	728	379	349	642	289	353	8213	888	453	435	5215	820	385	435
2	118000	116	4877	459	222	237	497	235	262	356	171	186	5758	717	342	375	3755	741	356	385
3	100000	194	4759	418	241	177	475	221	254	381	186	196	6128	671	312	359	3221	642	275	368
4	90100	232	5751	501	267	234	565	283	276	467	221	246	6768	655	310	345	3785	683	321	362
5	135000	130	3435	258	110	148	341	121	220	262	92	170	4970	538	173	365	2318	438	176	262
6	118000	180	5836	426	237	189	536	256	280	505	247	259	6474	670	335	335	3630	704	434	270
7	110000	61	3037	252	125	127	306	103	201	203	90	113	4426	555	303	252	2445	520	248	272
8	117000	135	5073	456	236	220	485	259	226	448	244	204	5620	664	353	311	3125	600	344	256
AVERAGE	112638	157	4979	406	211	195	492	232	259	408	193	216	6045	670	323	347	3437	644	317	326

Special Note on AM and PM Peak Hours

As defined in Appendix A, the AM and PM peak hours of trips entering and exiting the site driveway (peak hour of the generator) do not necessarily correspond to the peak volume hours of the adjacent street. Peak AM and PM hour driveway volumes are at least equal to or greater than the driveway volumes which correspond to the peak hour of the adjacent street. In the case of our study sites, the peak AM hour was from 11-12 am for each site. The PM peak hour was more variable, with the following distribution: Site #1 7-8pm, #2 1-2pm, #3 12-1pm, #4 7-8pm, #5 7-8pm, #6 5-6pm, #7 3-4pm, #8 12-1pm. The PM peak hour of the adjacent street ranged from 4:15-5:15pm to 5:00-6:00pm, with the majority of sites' adjacent street traffic peaking at 4:30-5:30pm.

Average Trip Rates

The data presented in Table 1 was utilized to obtain trip rates for each relevant time period. Precise definitions of the various trip rate terms are presented in **APPENDIX A** at the end of this memorandum. (Source: ITE Trip Generation 5th Addition). Average trip rates, as well as a comparison to the trip rates published in the ITE Trip Generation Manual 5th edition are presented in Table 2 and 3. Table 2 contains the rates derived from utilizing square footage as the predictive variable, and Table 3 reports the rates derived from using the number of employees as the independent variable. Rates from the ITE Trip Generation Manual are based on an extremely limited (one or in some cases two) site surveys. Therefore, any comparison made to the rates from the ITE Manual should be viewed as informative only.

Square Footage Trip Rates

Square footage trip generation rates for each time period are presented in Table 2. As will be seen in the following section on the regression equations developed from the traffic count data, the predictive value of the square footage of the building, as it relates to the number of trips a facility will be likely to produce, is rather weak. Further discussion on this subject can be found later in this report.

Wide variations exist in the square footage rates developed from the driveway count data. For instance, for the 24 hour weekday trip generation rates ranged from 25.44 to 63.83 per 1000 square feet. Peak hour trip rates per 1000 square feet were also found to be highly variable. For instance, PM peak hour trips rates range from a low of 2.53 trips per 1000 square feet to 6.44. In one sense, this wide range, illustrated by our representative sample, may make the average rate more useful. While perhaps not providing a particularly accurate trip rate per

TABLE 2

WHOLESALE CLUB TRIP RATES per 1000 sq ft. RETAIL SPACE

Site #	SQ.FT.	Wkday 24 Hr	Sat 24 Hr	Sun 24 Hr	AM Peak Hr Tot	AM Pk Hr In	AM Pk Hr Out	PM Peak Hr Tot	PM Pk Hr In	PM Pk Hr Out	PM Pk Adj. St.	PM Pk Adj.St. In	PM Pk Adj.St. Out	Sat Pk Hr	Sat Pk Hr In	Sat Pk Hr Out	Sun Pk Hr	Sun Pk Hr In	Sun Pk Hr Out
1	113000	62.50	72.68	46.15	4.26	2.21	2.04	6.44	3.35	3.09	5.68	2.56	3.12	7.86	4.01	3.85	7.26	3.41	3.85
2	118000	41.33	48.80	31.82	3.89	1.88	2.01	4.21	1.99	2.22	3.02	1.45	1.58	6.08	2.90	3.18	6.28	3.02	3.26
3	100000	47.59	61.28	32.21	4.18	2.41	1.77	4.75	2.21	2.54	3.81	1.86	1.96	6.71	3.12	3.59	6.42	2.75	3.68
4	90100	63.83	75.12	42.01	5.56	2.96	2.60	6.27	3.14	3.06	5.18	2.45	2.73	7.27	3.44	3.83	7.58	3.56	4.02
5	135000	25.44	36.81	17.17	1.91	0.81	1.10	2.53	0.90	1.63	1.94	0.68	1.26	3.99	1.28	2.70	3.24	1.30	1.94
6	118000	49.46	54.86	30.76	3.61	2.01	1.60	4.54	2.17	2.37	4.28	2.09	2.19	5.68	2.84	2.84	5.97	3.68	2.29
7	110000	27.61	40.24	22.23	2.29	1.14	1.15	2.78	0.94	1.83	1.85	0.82	1.03	5.05	2.75	2.29	4.73	2.25	2.47
8	117000	43.36	48.03	26.71	3.90	2.02	1.88	4.15	2.21	1.93	3.83	2.09	1.74	5.68	3.02	2.66	5.13	2.94	2.19
AVERAGE RATE		44.20	53.66	30.51	3.61	1.87	1.73	4.36	2.06	2.29	3.62	1.71	1.92	5.95	2.86	3.08	5.71	2.82	2.90
ITE RATE		78.02	82.43	61.79	6.34	3.42	2.92	9.67	4.54	5.13	7.79	3.9	3.89	N/A	N/A	N/A	N/A	N/A	N/A

1000 square foot, the resulting trip generation predictions will nonetheless represent a midpoint in the range of possible trip making levels for the various time periods. It should also be noted that the typical size of warehouse clubs tends to be consistently near 120,000 square feet. Therefore making an average rate more likely to yield an accurate trip generation prediction.

The study's trip generation rates based on square footage, when compared to the rates published in the ITE Trip Generation Manual, are generally much lower. The ITE rates were based on an evaluation of one site, the specific characteristics of which are not known. To illustrate this point, the ITE rate for the 24 Hr average weekday per 1000 square feet is 78.02, the average rate from our study is 44.20. For the PM peak hour, the ITE published rate is 9.67 trips per 1000 square foot, our study yielded a rate of 4.36 for the same time period.

Employee Trip Rates

Trip rates based on the number of employees at each site were developed for the full range of time periods and are presented in Table 3. These rates display much less variation than the square footage rates, and match the rates published in the ITE Trip Generation Manual much more closely. As will be discussed in greater detail in the section of this memorandum presenting the regression equations, it can be inferred from the data that, generally speaking, the number of employees at a site is a much more accurate predictor of trip making activity. This is most likely due to the fact that the number of employees more directly reflects the general level of business activity at each of the warehouse sites.

Trip generation rates per employee for the 24 hour average weekday time period range from a low of 24.59 to a high of 49.79, yielding an average trip rate of 31.76. The ITE published trip rate for this same time period per employee is 32.33. In the case of the employee trip generation rates, the ITE numbers are based on two survey sites. PM peak hour trip rates per employee vary between 2.44 and 5.02, resulting in an average rate of 3.14. The ITE published rate per employee for this time period is 3.78.

AM peak hour trip rates per employee range from 1.98 to 4.13, with the resulting average rate being 2.59. The ITE published AM peak hour trip rate per employee is 2.39. Slightly wider variation in rates result from the weekend counts. Saturday 24 hour rates range from 31.59 to 72.56 per employee, while the Saturday peak hour rate ranges from 2.82 to 9.10. The resulting Saturday average rates are 38.56 for the 24 hour and 4.27 for the peak hour. The ITE rates for Saturday are 33.97 for the 24 hour time period and 5.12 for the peak hour. Sunday trip rates per employee show a similarly wide variation. Sunday 24 hour trip rates range from 16.31 to 40.08, with the average being

TABLE 3

WHOLESALE CLUB TRIP RATES per EMPLOYEE

Site #	TOTAL # EMPLOY.	Wkday 24 Hr	Sat 24 Hr	Sun 24 Hr	AM Peak Hr Tot	AM Pk Hr In	AM Pk Hr Out	PM Pk Hr Tot	PM Pk Hr In	PM Pk Hr Out	PM Pk Adj. St.	PM Pk Adj.St. In	PM Pk Adj.St. Out	Sat Pk Hr	Sat Pk Hr In	Sat Pk Hr Out	Sun Pk Hr	Sun Pk Hr In	Sun Pk Hr Out
1	206	34.29	39.87	25.32	2.33	1.21	1.12	3.53	1.84	1.69	3.12	1.40	1.71	4.31	2.20	2.11	3.98	1.87	2.11
2	116	42.04	49.64	32.37	3.96	1.91	2.04	4.28	2.03	2.26	3.07	1.47	1.60	6.18	2.95	3.23	6.39	3.07	3.32
3	194	24.53	31.59	16.60	2.15	1.24	0.91	2.45	1.14	1.31	1.96	0.96	1.01	3.46	1.61	1.85	3.31	1.42	1.90
4	232	24.79	29.17	16.31	2.16	1.15	1.01	2.44	1.22	1.19	2.01	0.95	1.06	2.82	1.34	1.49	2.94	1.38	1.56
5	130	26.42	38.23	17.83	1.98	0.85	1.14	2.62	0.93	1.69	2.02	0.71	1.31	4.14	1.33	2.81	3.37	1.35	2.02
6	180	32.42	35.97	20.17	2.37	1.32	1.05	2.98	1.42	1.56	2.81	1.37	1.44	3.72	1.86	1.86	3.91	2.41	1.50
7	61	49.79	72.56	40.08	4.13	2.05	2.08	5.02	1.69	3.30	3.33	1.48	1.85	9.10	4.97	4.13	8.52	4.07	4.46
8	135	37.58	41.63	23.15	3.38	1.75	1.63	3.59	1.92	1.67	3.32	1.81	1.51	4.92	2.61	2.30	4.44	2.55	1.90
AVERAGE RATE		31.76	38.56	21.93	2.59	1.35	1.25	3.14	1.48	1.65	2.60	1.23	1.38	4.27	2.06	2.21	4.11	2.02	2.08
ITE RATE		32.33	33.97	24.82	2.39	1.29	1.1	3.78	1.78	2	3.19	1.6	1.59	5.12	2.87	2.25	4.61	2.63	1.98

21.93. Sunday peak hour rates range from 2.94 to 8.52, averaging 4.11. ITE Sunday employee trip rates are 24.82 for the 24 hour and 4.61 for the peak hour.

Regression Analysis

Regression equations for each of the time periods were developed for both the square footage and employee variables. A detailed description of the methodology utilized to develop the equations can be found in **APPENDIX B**, at the end of this memorandum.

Results of Regression Analysis

In many cases, the Best Fit Equation resulting from our study data were determined to be inappropriate for use, due in large part either to an extremely low R^2 value or a negative slope of the equation line (in other words there was not an increasing relationship between the independent variable and the number of trips). For further discussion on the particulars of the regression analysis see APPENDIX B. Scatterplots of the data points, and where relevant, the equation lines for each time period and independent variable combination are included in **APPENDIX C.**

In an effort to develop better equations, a systematic review of the benefits of reducing the sample size by removing "outlier" values was performed. This process did not yield any clear results. This outcome was due in part to the fact that there were no sites which consistently yielded outlier values across the time periods tested. In addition, removing any one or two particular data points did not significantly enhance the regression analysis outcome. In an alternative attempt to achieve better fit equations, supplementation of the data set, with additional data from an alternative source yielded similarly unsatisfactory results. Therefore, we retained our complete data set for use in developing our equations.

Square Footage Trip Rate Equations

As a result of the above outlined regression analysis and application of the ITE guidelines concerning the suitability of resulting equations, there were no trip generation equations deemed suitable for use with the Square Footage variable. This was not the case for the employee trip generation equations. The equations developed utilizing the employee variable are presented in Table 4.

Upon discovering the apparent lack of correlation between the square footage of the Warehouse Club and its trip generation

characteristics, we hypothesized several potential explanations. An examination of these follow.

1. Fundamentally Unique Form of Retailing.

Warehouse Clubs represent a completely new and unique form of retailing. Unlike traditional retailing, where display of goods plays a key sales role, warehouse retailing depends on the sale of goods at a discount price, with consistent availability of a limited number of items. In other words, floor space for display becomes less of a determining factor for sales. Warehouse club interiors are just that, "warehouses", often characterized as a no frills interior. Size may be a stronger predictor of trip generation for traditional retailing. Shoppers often choose to go to larger retail establishments because the greater size is equated with a greater product mix. This is not the case with warehouse clubs, who market themselves based on a given product and service line and promised discounts. In addition to this fundamental difference in marketing strategy from traditional retailing, several other features of warehouse clubs may be contributing to the lack of correlation between square footage and trips generated.

2. Membership Requirements Limit Freedom of Choice.

Membership levels are key determinants of business activity levels at warehouse clubs. The entire phenomenon of being a member at a particular club will have wide ranging impacts on the trip making characteristics of warehouse clubs. A potential patron will not simply choose to stop at another company's warehouse club because they happen to be driving by. In addition, because the membership is good for a year, if a competitor's club opens in a location convenient to the customer, they will still be likely to wait until their existing membership expires (up to one year) before switching stores. Therefore, establishing a strong client base is a lengthy process, therefore delaying by as much as a year, the "peak activity potential" of the warehouse.

3. Reuse of Existing Structures.

Another factor directly relevant to the question of square footage as a potential predictor of trip generation is that some Warehouse Clubs have apparently located in pre-existing structures, therefore making do with a particular structure's size. Perhaps the Warehouse Club can be flexible with its space requirements for several reasons. Additional floor space can be relatively inexpensive because of its "no-frills" interior characteristics. Also, additional space would simply allow for greater product storage area (which is not a separate space requirement from "display"). The apparent willingness to work

with what's available instead of needing to build a custom designed new structure illustrates that square footage is not a very strong determining factor in warehouse club facility design or placement.

4. Warehouse Clubs May Be Particularly Location Sensitive.

Variation in business activity levels are dependent on location. In general, those clubs located near large population centers, with ease of access have a definite advantage. Therefore, the locational differences between our sites could be a more significant variable than the size of the club's physical structure. Warehouse clubs may appeal to a particular population subset and therefore a limited segment of the market area population. This niche marketing would therefore make population density and market saturation especially significant factors in warehouse club business success.

Employee Trip Rate Equations

Table 4 presents the trip rate equations developed for the employee variable. The number of employees, as one might assume, appears to be a fairly good predictor of business activity at warehouse clubs. This is in part due to the ability of management to scale the workforce to match business levels. The R^2 values resulting from the regression analysis range from .69 for the Saturday 24 Hour equation to .28 for the Saturday Peak Hour equation.

As has been pointed out by several consultants and real estate developers, utilizing this variable to predict trips can be problematic, in that it is often difficult to estimate the number of employees accurately before a store is built and operating. In addition, because it is not a fixed or "concrete" attribute, regulators are concerned about predictability and accountability. For instance, in order to minimize the predicted traffic impacts of a development, a proponent could underestimate the future number of employees, with increases in workforce being implemented after the facility has been permitted and built. To address this concern we have recommended a procedure for cross-checking estimates of employment levels. A description of this procedure can be found at the end of this report in the section entitled "Recommendations for use of Study Results".

The values of R^2 range from .28 for the Saturday Peak Hour equation to .69 for the Saturday 24 Hour Trip Equation.

TABLE 4

TRIP GENERATION EQUATIONS FOR EMPLOYEES

RELATION	BEST-FIT EQUATION	R-Squared
24 Hour Weekday Trips / Employee	T= 18.24 (x) + 2120.26	0.62
24 Hour Saturday Trips / Employee	T= 17.20 (x) + 3348.64	0.69
24 Hour Sunday Trips / Employee	T= 10.39 (x) + 1808.04	0.41
AM Peak Hour Trips / Employee	T= 1.24 (x) + 212.79	0.51
PM Peak Hour Trips / Employee	Ln(T) = .51ln (x) + 3.61	0.64
PM Peak Adjacent Street / Employee	Ln(T)=.72ln (x) + 2.37	0.70
Saturday Peak Hour / Employee	T= 1.02 (x) + 510.37	0.28
Sunday Peak Hour / Employee	Ln(T)= .47ln (x) + 3.64	0.53

Conclusion

The completion of this study adds significantly to the body of knowledge available on the trip generation characteristics of membership warehouse clubs. We believe the sites selected for study represent a true sampling of the vehicle trip characteristics of warehouse clubs, in that the sites were carefully selected for likeness in product line and store operation characteristics, yet represent a diversity of corporate identity and locational attributes.

Despite the lack of a strong correlation between the square footage of a facility and the vehicle counts, we believe the rates developed for this variable will nonetheless prove useful. The average size of warehouse club facilities does not vary significantly, thereby diminishing the potential for a strong correlation between size and trip generation. In lieu of utilizing the square footage rates, the employee trip generation equations will provide an even greater degree of predictive confidence, if knowledge of the number of employees (or potential employees) working at a site is available.

Recommendations for Use of Study Results

We anticipate that the trip generation rates and equations presented in this report will be utilized by MEPA, traffic consultants and warehouse club development proponents to estimate the potential traffic impacts of new warehouse club developments. To that end, we propose the following method to "confirm" the accuracy of the employment-derived trip generation forecasts.

1. The project proponent should provide a best estimate of the total workforce, as anticipated for the project when it is a fully operational, well-established warehouse club operation.

2. This original estimate of employment level should be based on the average workforce required for the well-established warehouse clubs of the proponent's corporation. By being corporate-specific, the variability between the business and marketing practices would be accounted for. By using an average for the corporation, site-specific locational differences would be neutralized as well.

3. This number should be compared to the range and averages of workforce levels for the sites contained in the study data, as a check for reasonableness. A calculation of both the range of and average employees per 1000 square feet for the sites can be found in the Traffic Count and Trip Rate Results section of this report. The estimated workforce of the proposed facility should fall within this range.

4. Only if documented unique conditions exist should the anticipated workforce level deviate significantly from the

corporate average or fall outside of the range of those sites included in the study.

5. Trip rate equations should be applied to the employment forecast to develop trip generation predictions.

6. Average trip generation rates per 1000 sq. ft. from the study could be utilized for comparative purposes and/or development of a range of possible trip generation outcomes.

7. Because employment is not a "fixed" variable in the way square footage is, it may be advantageous to establish a monitoring procedure. Actual employment levels and/or trip generation rates could be obtained after the facility was operational for a year or more, with the potential for adjusting any prescribed mitigation measures at that time.

APPENDIX A

DEFINITION OF TRIP RATES

Average Weekday Trip Rate: A weighted average vehicle trip generation rate during a 24 hour period for a weekday (Monday through Friday). This represents trips using a site's driveway(s). In the case of our particular study, a full week's worth of data was utilized to arrive at this weekday average volume. In addition, in some cases there was more than one week's worth of data available for each site. When this was the case the same days were first averaged (ie when several Monday's worth of data were available, an average volume for each hour on Monday was derived) and then the full week of averaged hourly weekday counts were utilized to derive the 24 hour average weekday count.

Average AM and PM Trip Rate for Peak Hours of the Generator: A weighted average vehicle trip generation rate during the hour of highest volume of traffic entering and exiting the site in the morning or afternoon. It may or may not coincide in time or volume with the trip rate for the peak hour of the adjacent street traffic. The trip rate for the peak hour of the generator will be equal to or greater than the trip rate for the peak hour between 7 and 9 AM or between 4 and 6 PM. This rate represents trips using a site's driveway(s).

Average Trip Rate for Peak Hour of the Adjacent Street Traffic: The highest one-hour weighted average vehicle trip generation rate between 7 and 9 AM or between 4 and 6 PM, when the adjacent street traffic is at its peak. This rate represents trips using a site's driveway(s).

Average Saturday Trip Rate: The weighted average vehicle trip generation rate during a 24-hour period for a Saturday. This rate represents trips using a site's driveway(s). In the case of our study, there were several sites which had multiple Saturday's counted. In this case, hourly volumes were averaged, to develop average Saturday hourly volumes which were then used to determine the average Saturday trip rate.

Average Sunday Trip Rate: The weighted average vehicle trip generation rate during a 24-hour period for a Sunday. This rate represents trips using a site's driveway(s). In the case of our study, there were several sites which had multiple Sunday's counted. In this case, hourly volumes were averaged, to develop average Sunday hourly volumes which were then used to determine the average Sunday trip rate.

Average Trip Rate for Saturday Peak Hour of Generator: The weighted average vehicle trip generation rate during the hour of highest volume of traffic entering and exiting a site on a Saturday. This rate represents trips using a site's driveway(s),

and in our case incorporates the average of several Saturdays at those site's where multiple Saturday's were counted.

Average Trip Rate for Sunday Peak Hour of Generator: The weighted average vehicle trip generation rate during the hour of highest volume of traffic entering and exiting a site on a Sunday. This rate represents trips using a site's driveway(s), and in our case incorporates the average of several Sundays at those site's where multiple Sunday's were counted.

APPENDIX B

REGRESSION ANALYSIS METHODOLOGY

The Macintosh program "Statworks" was utilized for this task. For each set of data tested, the program generated a scatterplot, a graph of the resulting regression equation (when relevant) superimposed on the scatterplot, the actual equation and other statistical results, including the R^2 value which measures the "goodness of fit" between the data points and the regression line produced by the equation. The coefficient of determination (R^2) is the percentage of the variance in the number of the trips associated with the variance in the size of the independent variable. In addition to producing these results, "Statworks" facilitates the development and testing of each of the following types of regression equations, namely, linear ($T = aX + b$), logarithmic ($Ln(T) = aLn(X) + b$), linear-logarithmic ($T = aLn(X) + b$), and logarithmic-linear ($Ln(T) = aX + b$). For each of the data sets, each of the above listed equation types were developed, in a effort to find that equation with the best predictive value.

ITE publishes guidelines to determine whether or not an equation has an acceptable predictive capability. We have adopted the ITE guidance for use in reporting the results of our regression analysis as well. As a result, best fit curves are presented only if the following criteria were met:

1. The R^2 is greater than or equal to 0.25.

2. The sample size is greater than or equal to 4. (This is true in all cases for our study.)

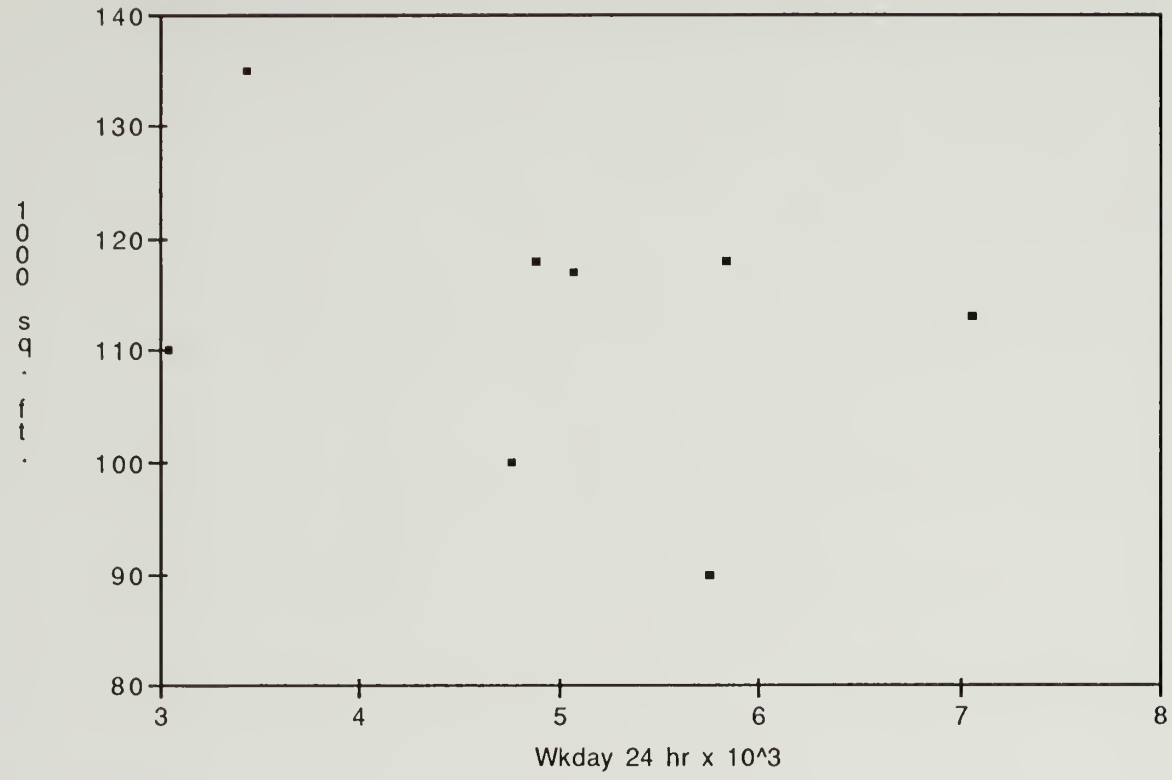
3. The number of trips increases as the size of the independent variable increases. (In other words the regression line has a positive slope.)

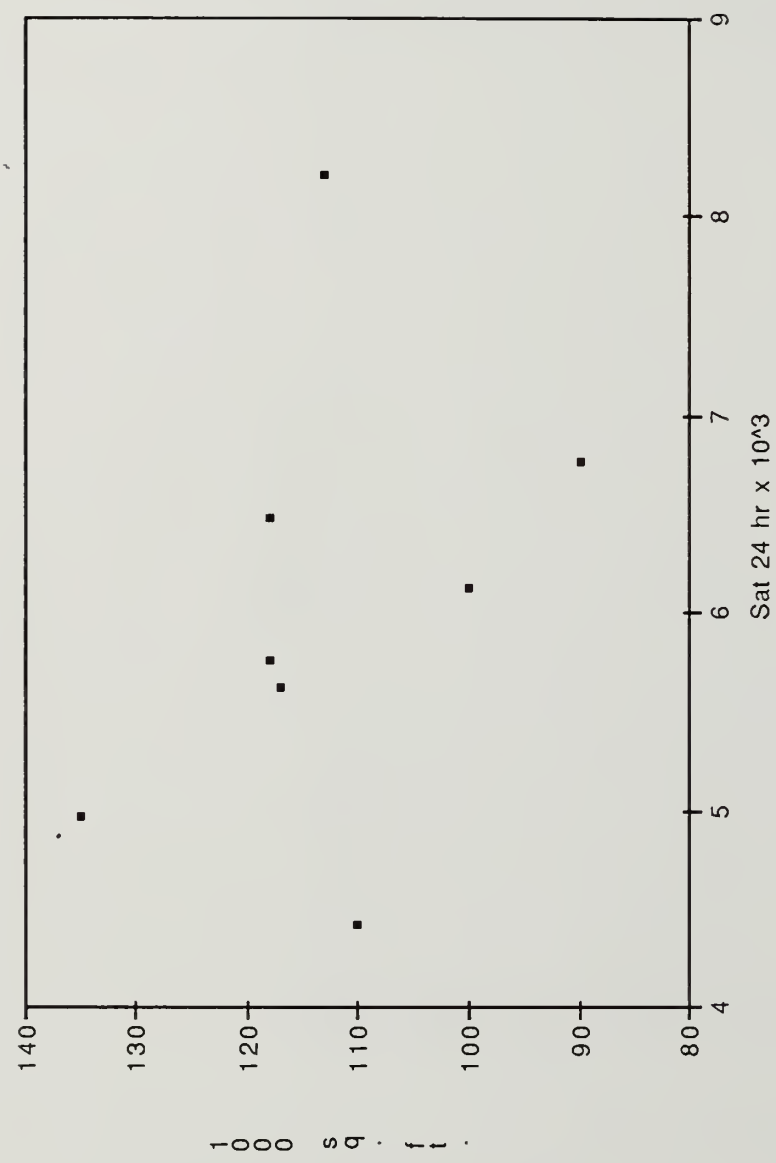
In addition, ITE guidance is given as to which type of equation should be used in a given circumstance, which we have utilized in this report as well. In general the preferred form of equation is the linear, due primarily to its ease of use and the logic behind the assumption of a linear relationship existing between a given predictive variable and the resulting trip generation prediction. When the linear equation did not produce a logical fit to the actual data, other equation types were examined. Alternative equation forms were determined preferable if they provided a better fit to the data, with the following exception. If the linear model was not the model with the highest R^2, but its R^2 was only slightly lower (no more than 0.05 less than that of the equation with the highest R^2), the linear model was still selected for use.

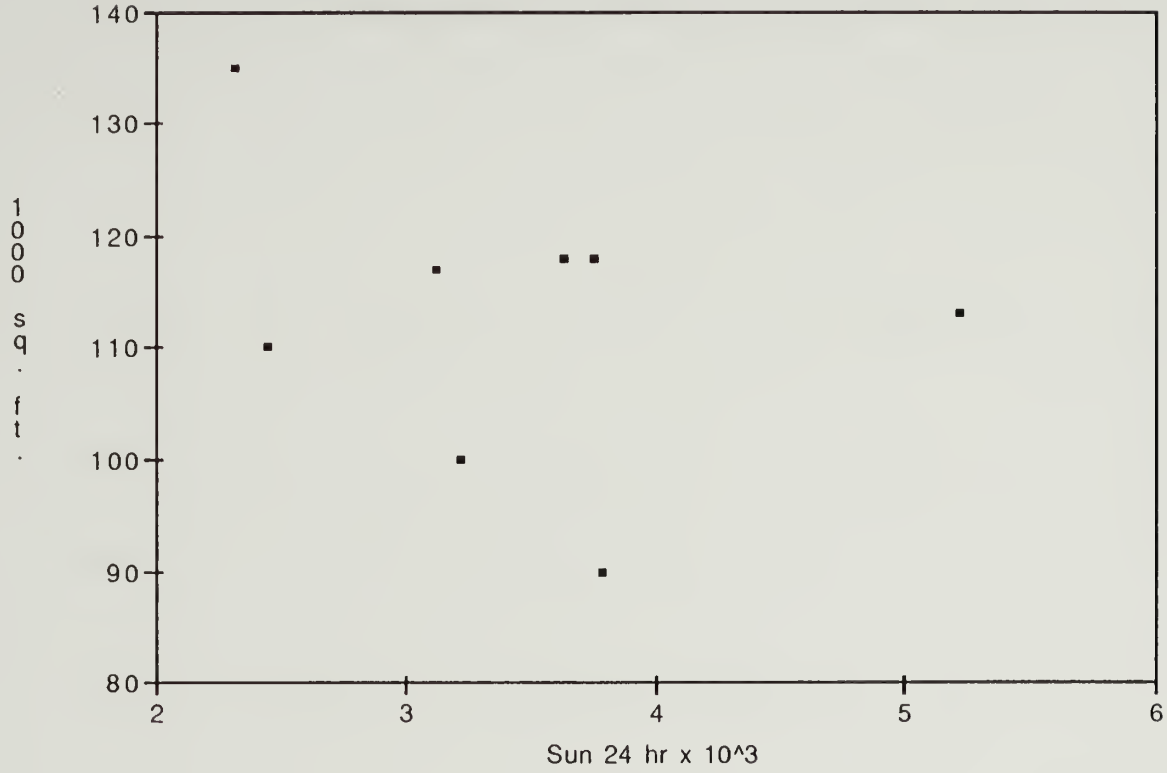
APPENDIX C

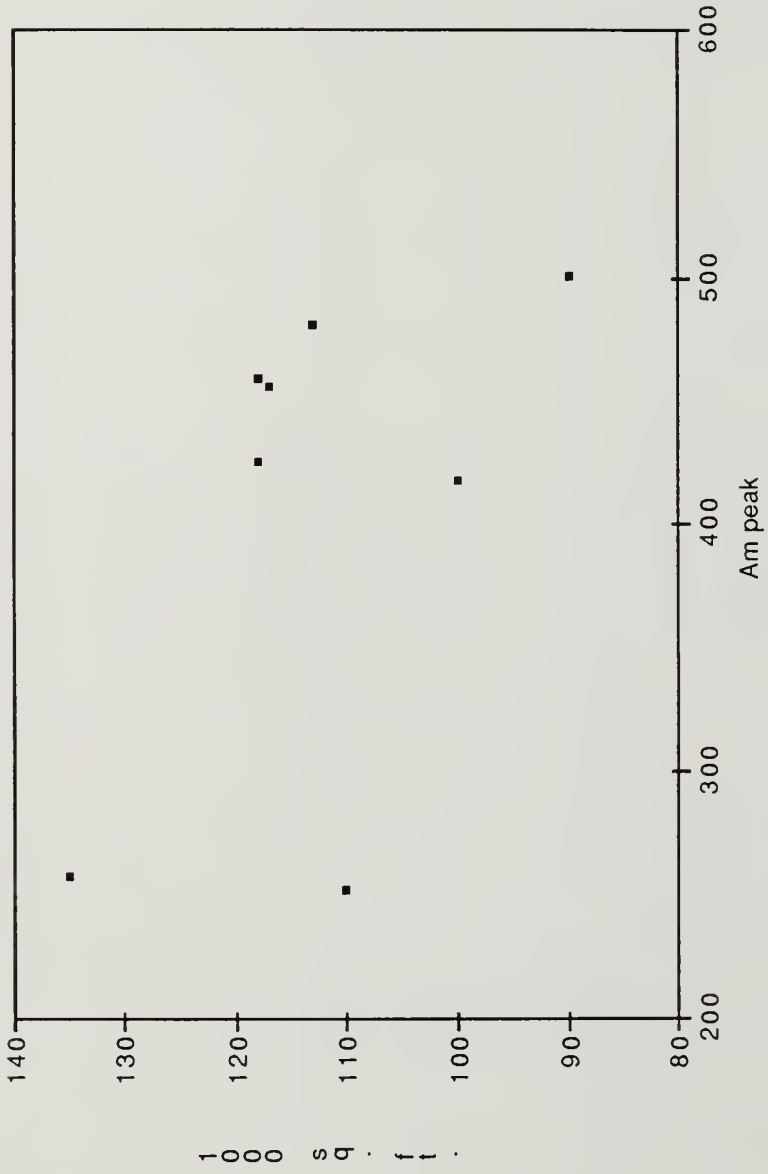
SCATTERPLOTS OF DATA POINTS

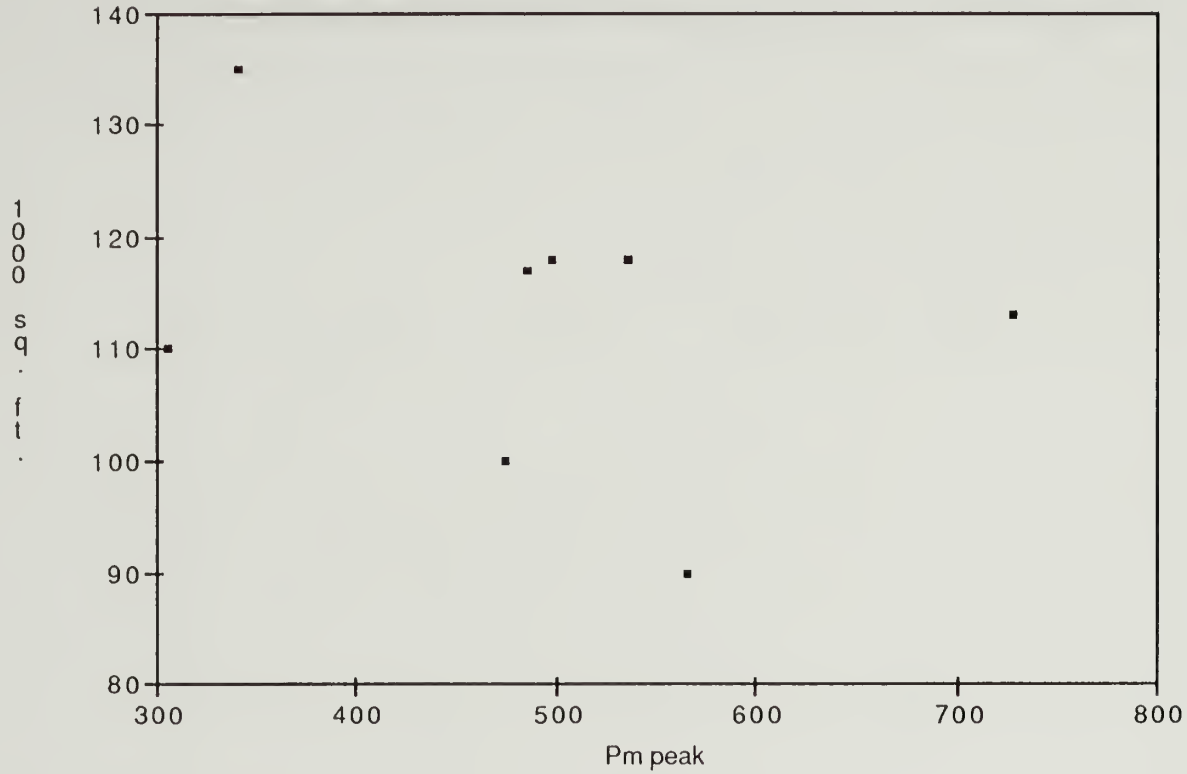
The following scatterplots are the actual outputs from the regression analysis program utilized, as described in Appendix B, Regression Analysis. Graphs showing the data points for the square footage independent variable and the various time periods are included, as well as the graphs showing both the data points and resulting regression lines for the employee independent variable.

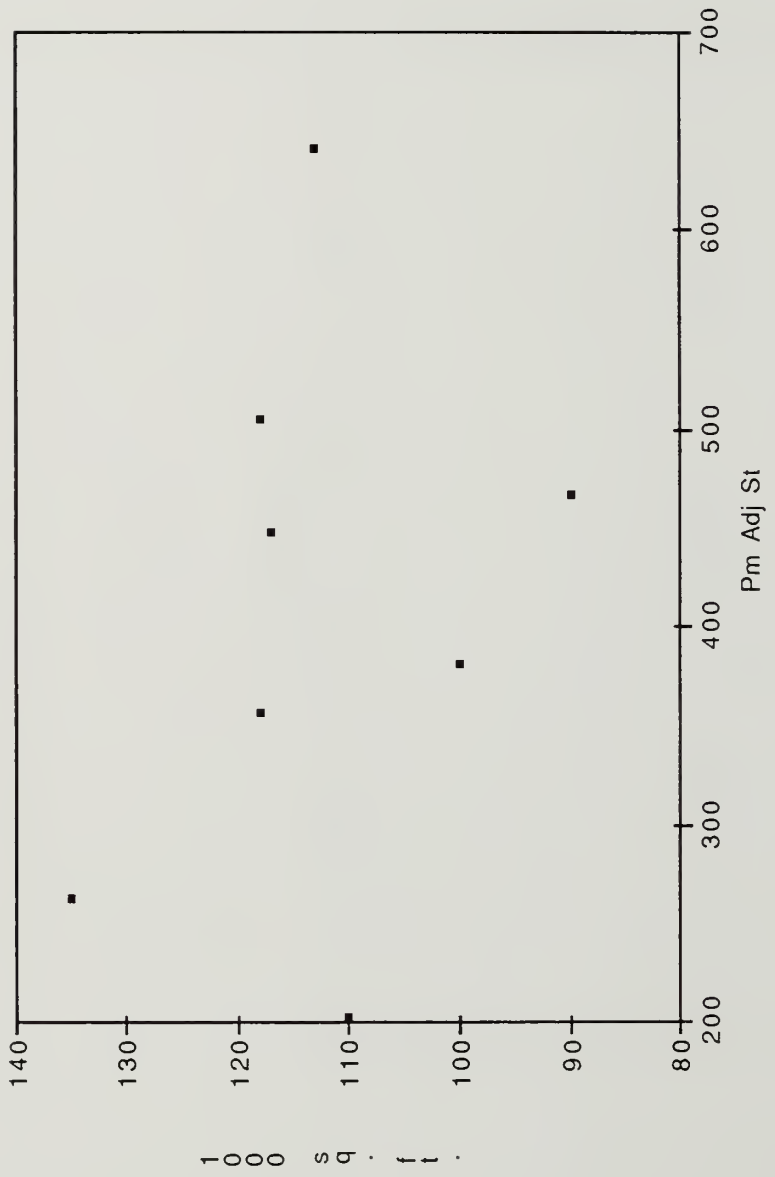

140
130
120
110
100
90
80
1000 sq. ft.
3
4
5
6
7
8
Wkday 24 hr x 10^3

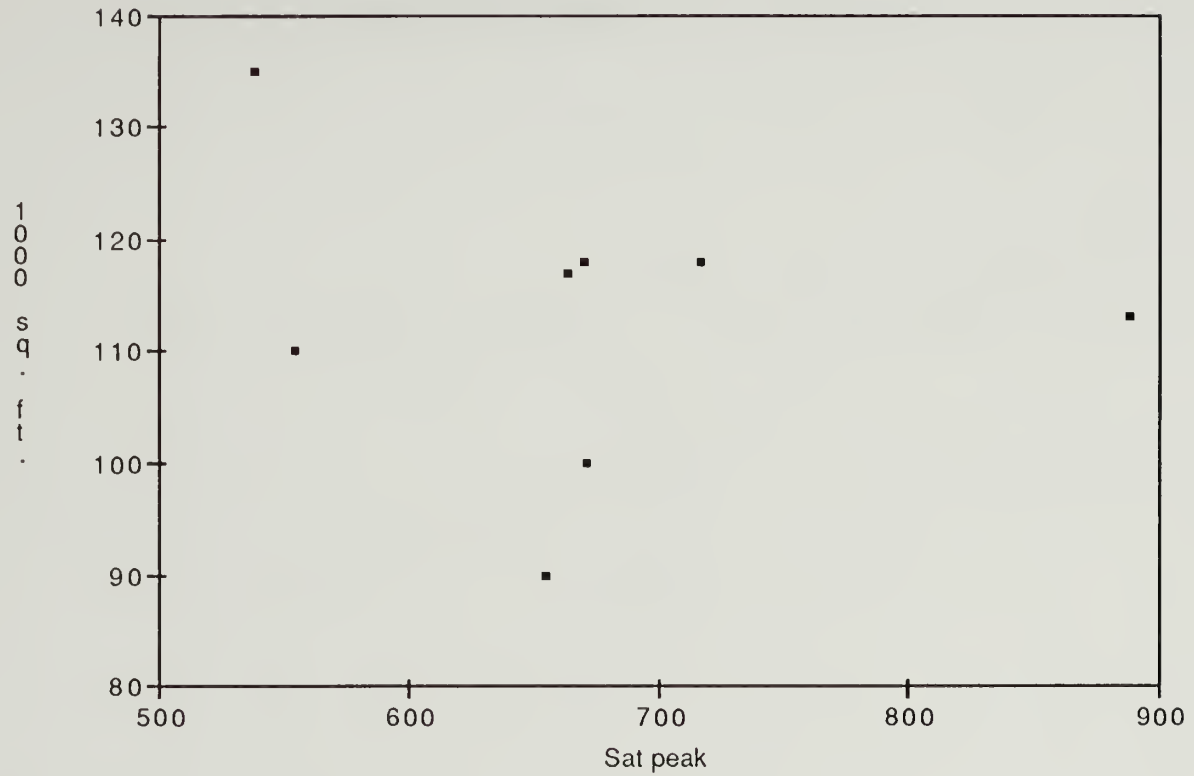

140
130
120
110
100
90
80
4
5
6
7
8
9
Sat 24 hr x 10^3
1000 sq. ft.

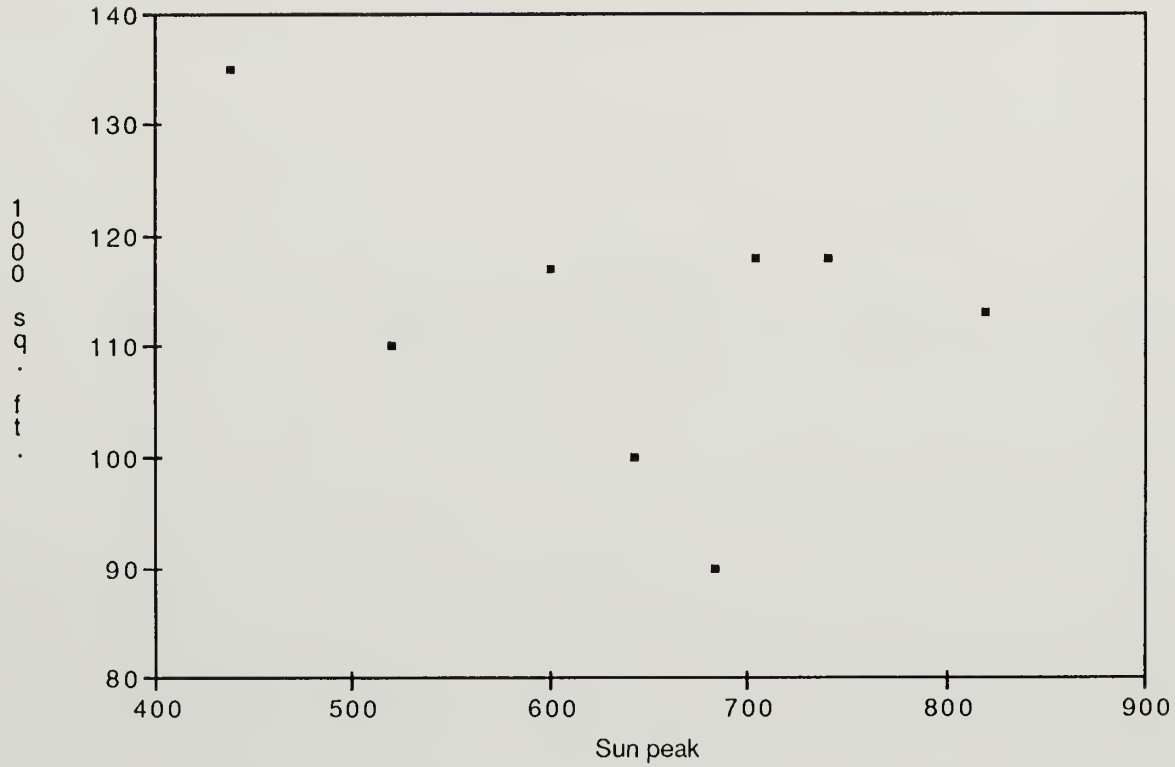

140
130
120
110
100
90
80
1000 sq. ft.
2
3
4
5
6
Sun 24 hr x 10^3

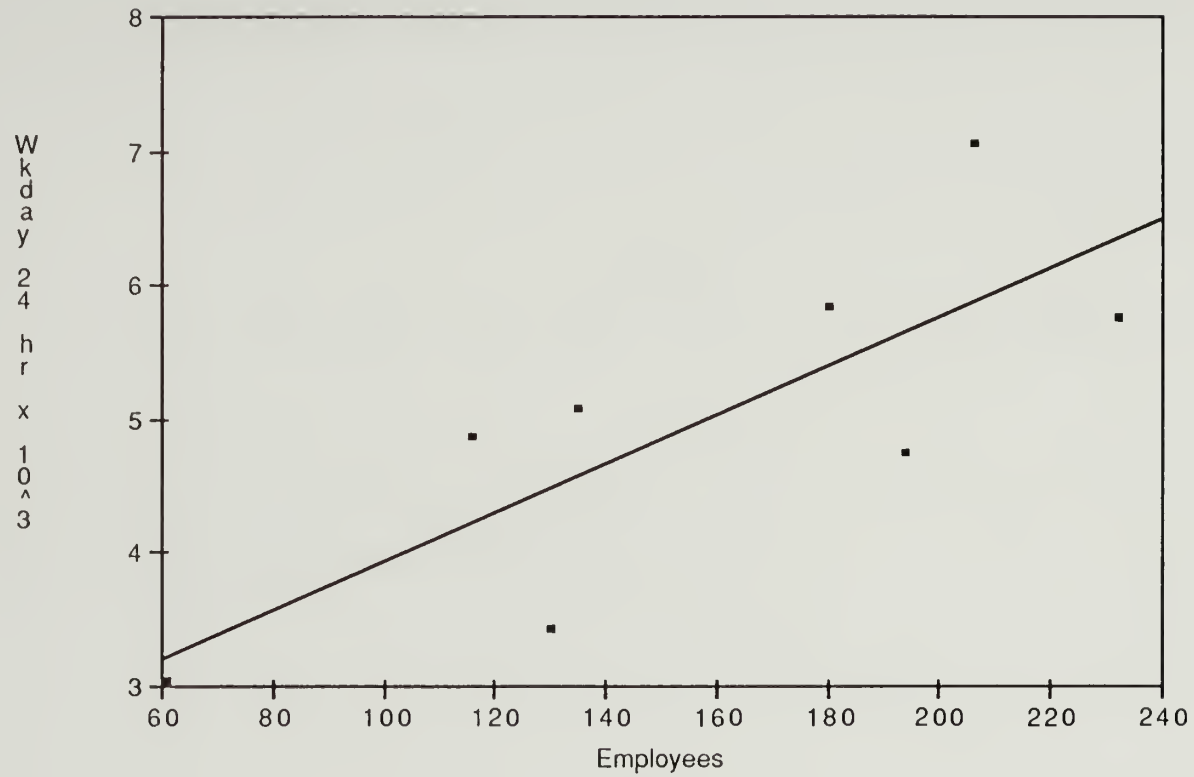

140
130
120
110
100
90
80
1000 sq. ft.
200
300
400
500
600
Am peak

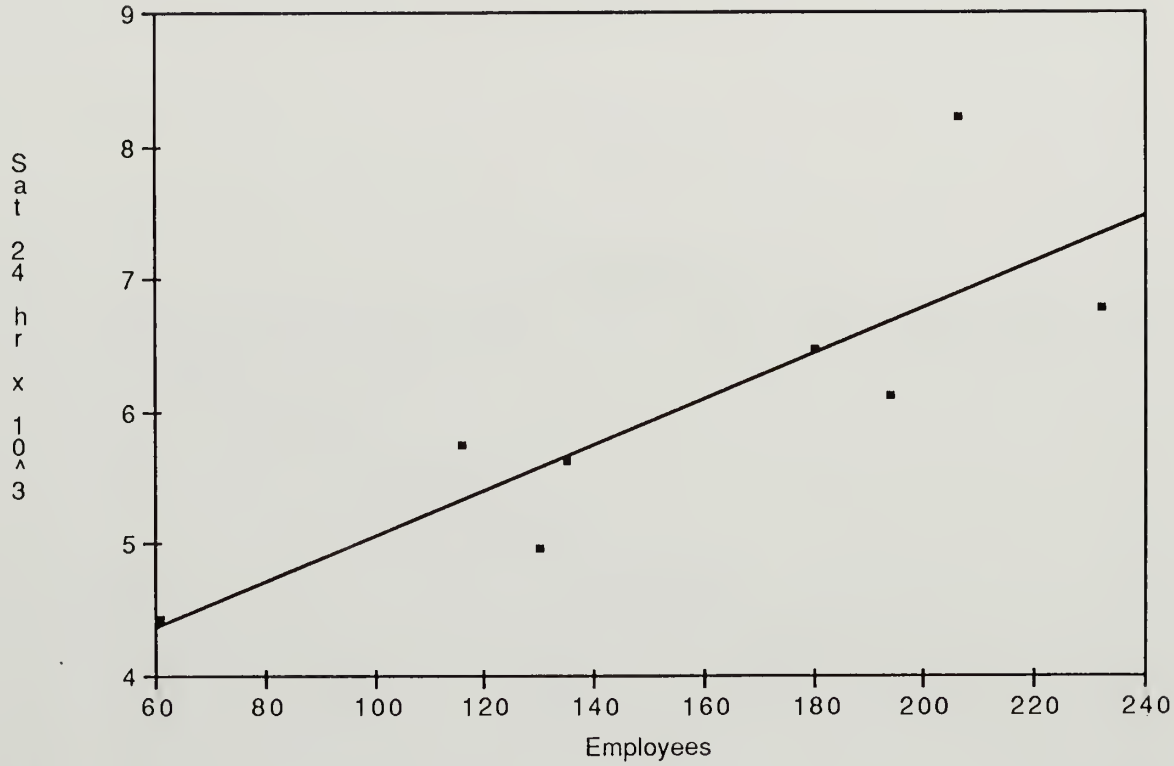

140
130
120
110
100
90
80
1000 sq. ft.
300
400
500
600
700
800
Pm peak

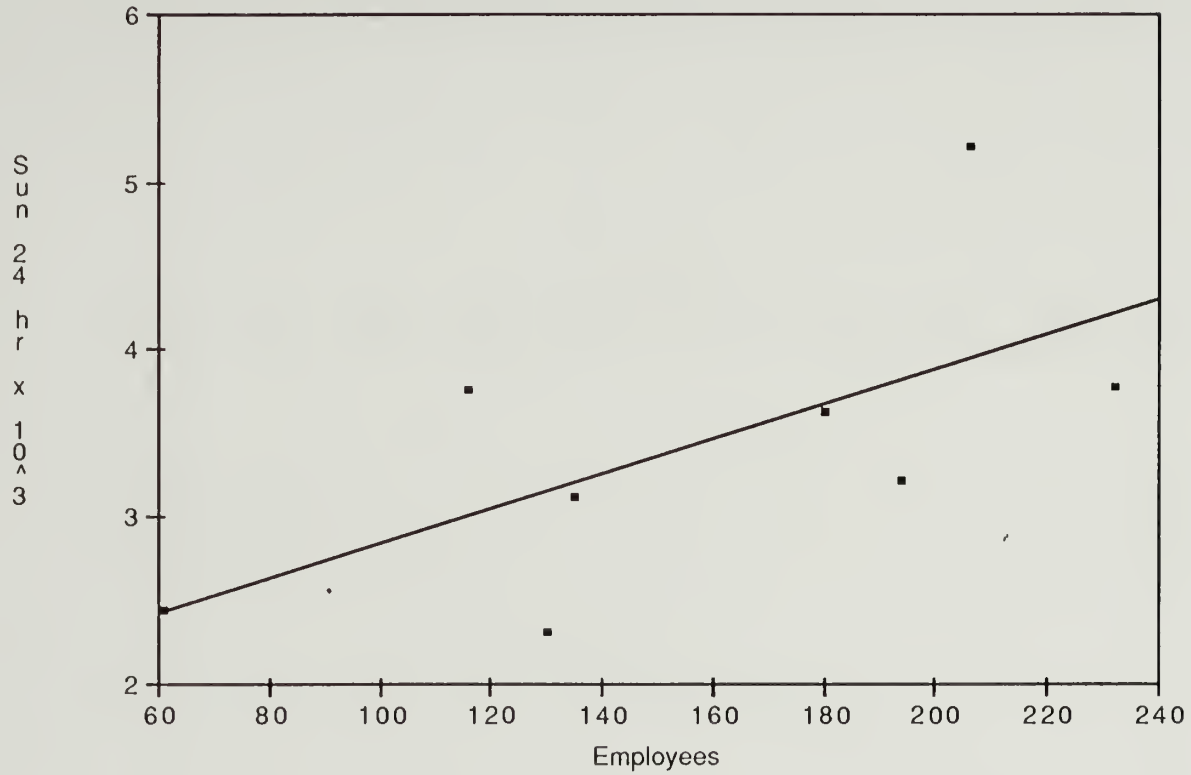

1000 sq. ft.
140
130
120
110
100
90
80
200
300
400
500
600
700
Pm Adj St


140
130
120
110
100
90
80
1000 sq. ft.
500
600
700
800
900
Sat peak


140
130
120
110
100
90
80
1000 sq. ft.
400
500
600
700
800
900
Sun peak


Wkday 24 hr x 10^3
8
7
6
5
4
3
60
80
100
120
140
160
180
200
220
240
Employees


9
8
7
6
5
4
Sat 24 hr x 10^3
60
80
100
120
140
160
180
200
220
240
Employees


Sun 24 hr x 10^3
6
5
4
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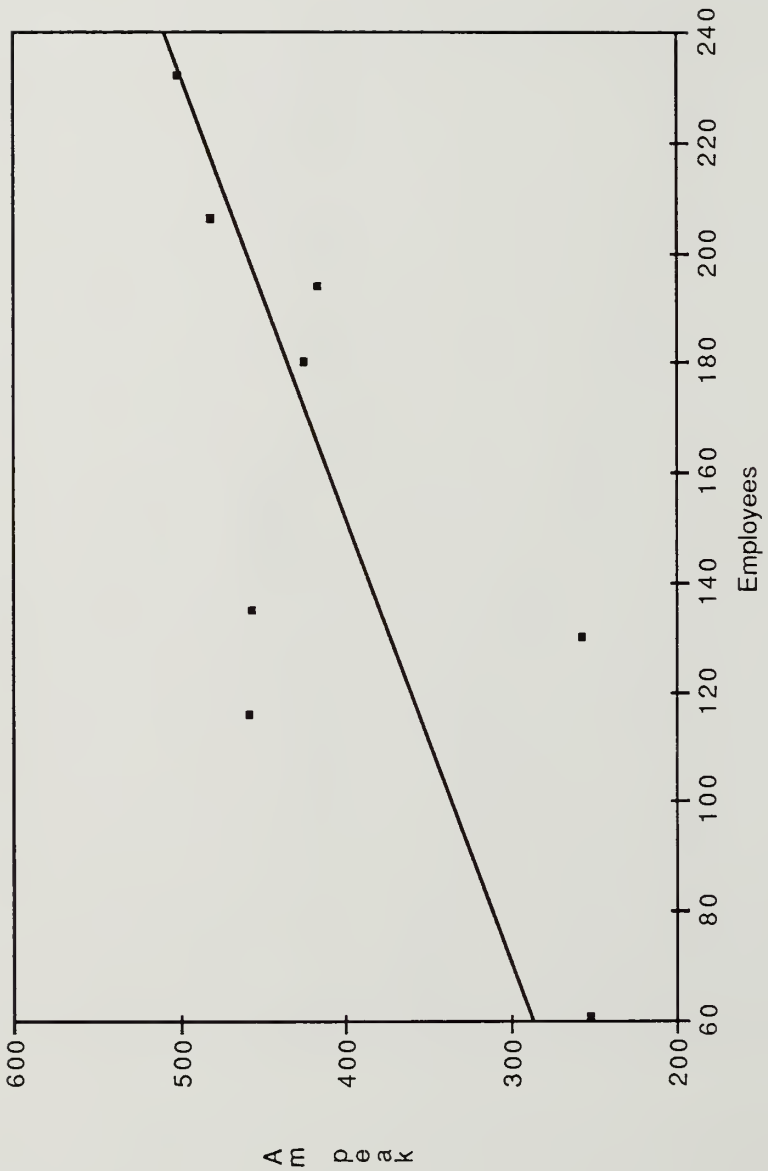
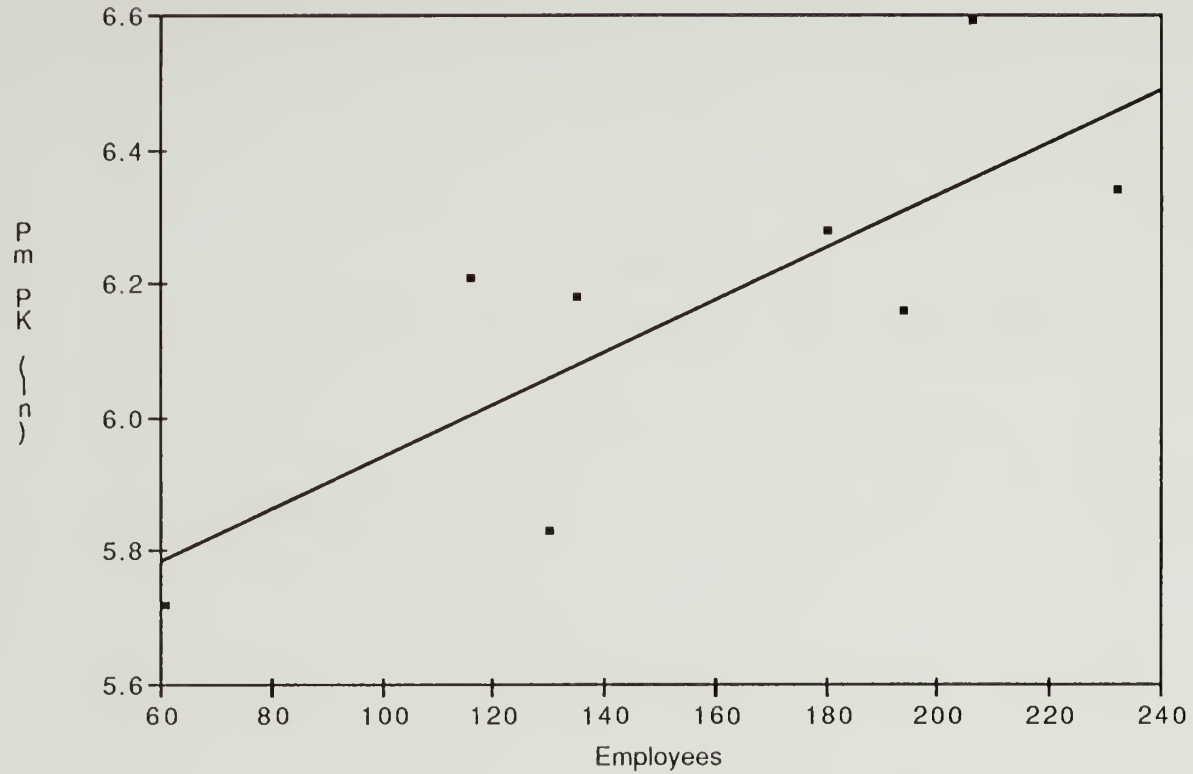
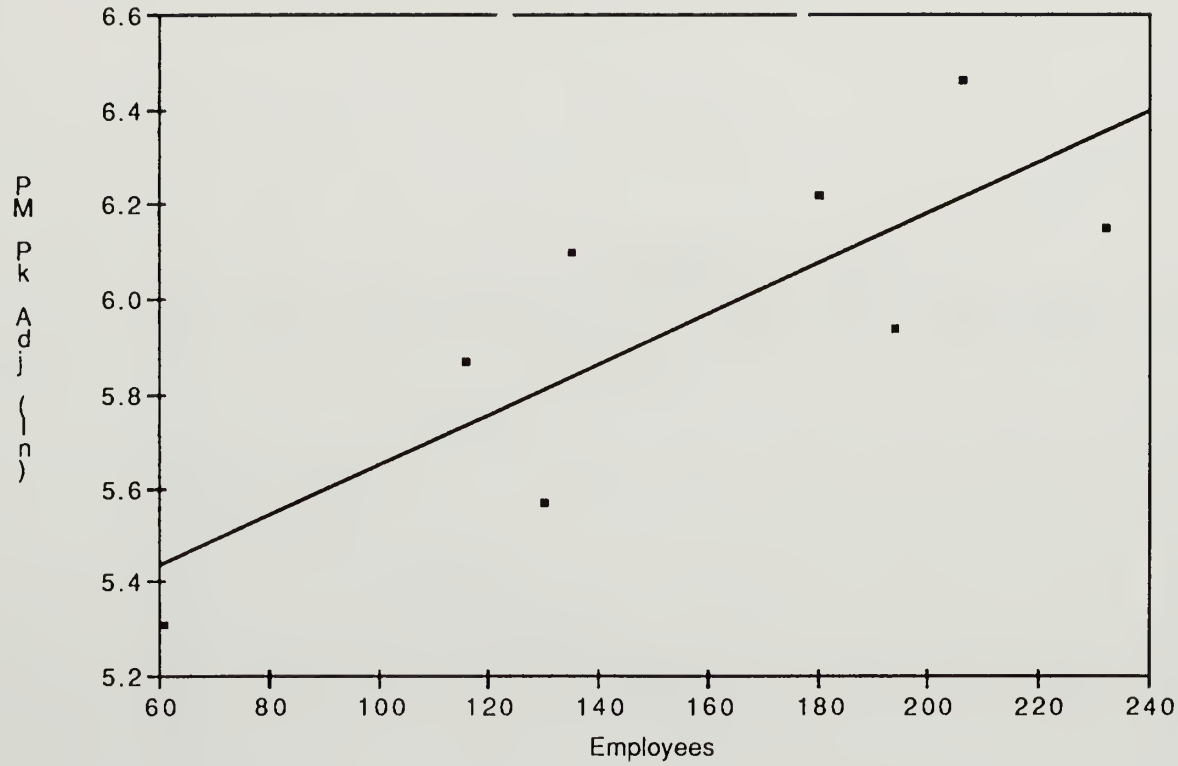
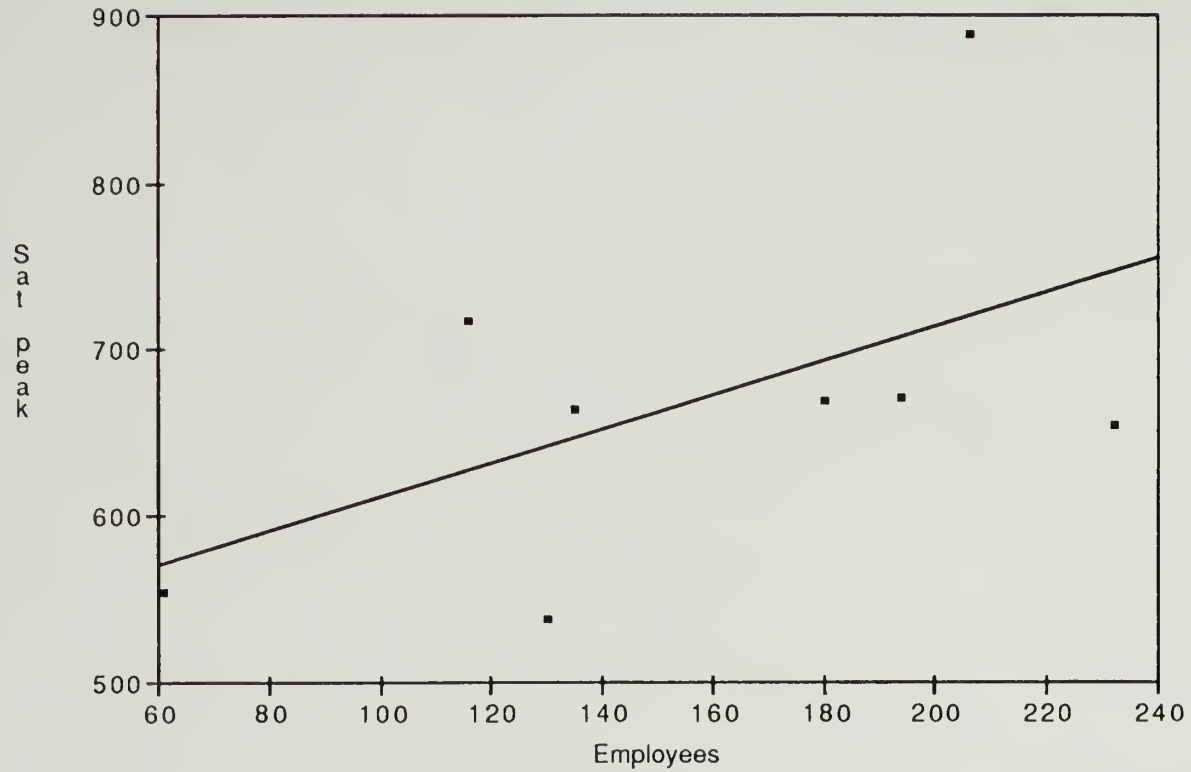
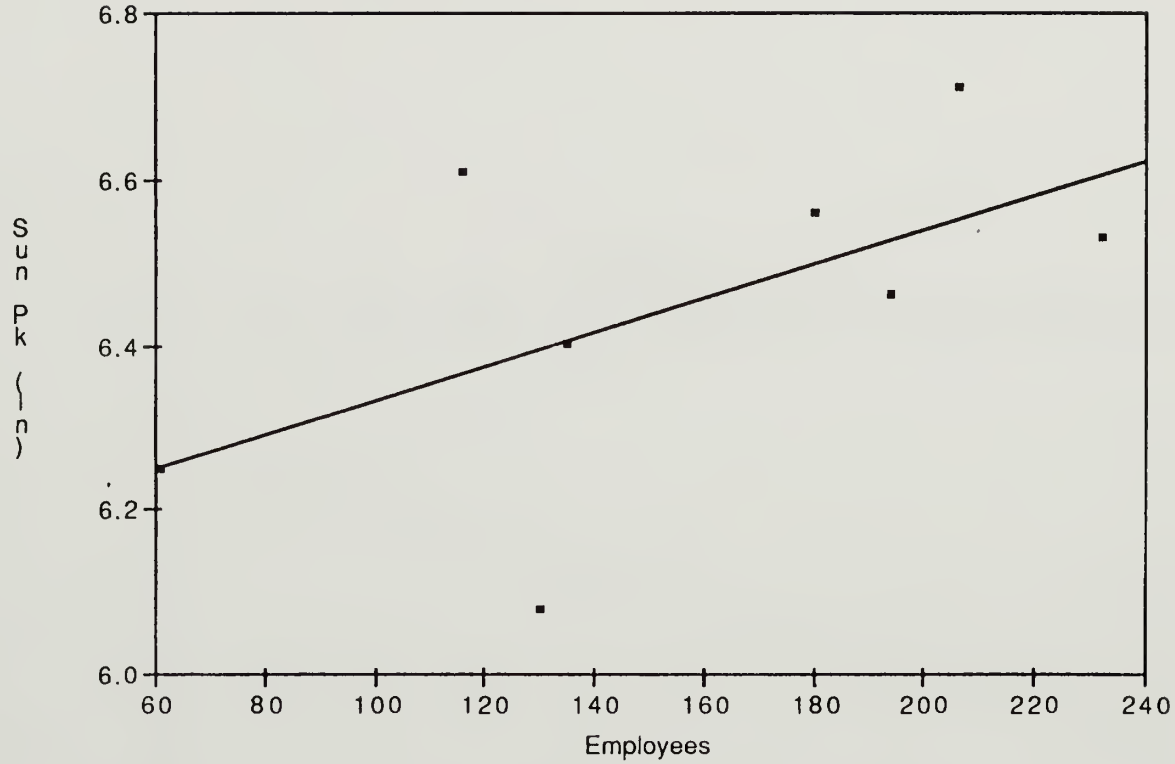
200
220
240
Employees


600
500
400
300
200
A
m
p
e
a
k
60
80
100
120
140
160
180
200
220
240
Employees


6.6
6.4
6.2
6.0
5.8
5.6
60
80
100
120
140
160
180
200
220
240
Employees


6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
PM Pk Adj (ln)
60
80
100
120
140
160
180
200
220
240
Employees


900
800
700
600
500
Sat peak
60
80
100
120
140
160
180
200
220
240
Employees


6.8
6.6
6.4
6.2
6.0
Sun Pk (ln)
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80
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220
240
Employees